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UTAH SCIENCE

UTAH STATE UNIVERSITY

AGRICULTURAL EXPERIMENT STATION

VOLUME 54 SPRING 1993 NUMBER 1



UTAH SCIENCE

UTAH AGRICULTURAL EXPERIMENT STATION
UTAH STATE UNIVERSITY
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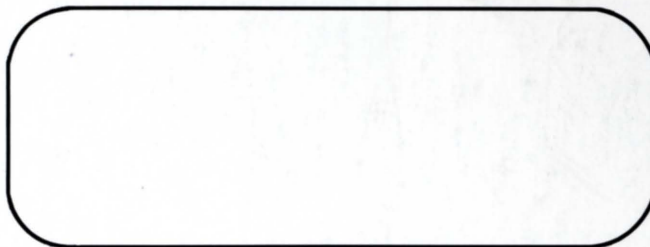
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UTAH STATE UNIVERSITY



UTAH SCIENCE

UTAH STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION VOLUME 54 SPRING 1993 NUMBER 1



This issue focuses on livestock-related research.

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Noelle Cockett

Breeding Livestock, Gene by Gene

There's a revolution brewing in livestock production, and it's all in the genes.

For centuries, livestock producers have tinkered with heredity in order to breed better livestock. It worked, but nothing like what's in store when farmers can construct livestock trait by trait.

"In the next two to four years, researchers will identify many of the genes that show the true productive potential of an animal. Producers will no longer have to keep a newborn animal more than a few days in order

TARGETED DISEASE TREATMENT

Trichomonus foetus, a protozoan, doesn't harm carrier bulls, but it can cause cows to abort. It survives even in frozen semen.

USU virologist Keven Jackson hopes to target a treatment for the venereal disease, employing a technique often used in cancer treatment.

Rabbits injected with the protozoa develop antibodies against the organism. Jackson and USU virologist Bill Barnett will isolate these antibodies and bind them to gelonin, a toxin so potent that one molecule can destroy an entire cell. These antibodies are then equipped to seek out and destroy *T. foetus*.

The resulting product can then be topically applied to bulls, targeting and killing the protozoa. The protozoa are found on the external genitalia of bulls, and don't trigger a natural immune response by bulls.

KG Keven Jackson
750-1887

to assess its ability," says USU molecular geneticist Noelle Cockett.

Cockett is identifying genes associated with diseases in sheep and cattle, and the muscle composition of sheep. She recently found a marker associated with heavy muscling in sheep, a prelude to selecting sheep for the trait.

The hindquarters of heavily muscled sheep contain about 2 percent more muscle and about 5-6 percent less fat. (Most of the valuable cuts, such as chops and leg of lamb, are derived from the back and hindquarters, respectively.) And unlike "double muscling," a similar trait in cattle, heavy muscling in sheep is not expressed until several weeks after birth, so it doesn't increase lambing problems.

Other USU researchers with the Center for the Genetic Improvement of Livestock, one of the state's Centers of Excellence at USU, are examining the flavor, tenderness and other characteristics of the meat from heavily muscled sheep. The project also involves researchers at Texas Tech University, Washington State University, the University of Idaho, and the USDA. Sheep Experiment Station in Dubois, Idaho.

"The palatability and tenderness of the meat from these animals is unknown at this time," Cockett says. "There has been considerable research in heavy muscling in beef, but relatively little research involving sheep. Our findings with these heavily muscled sheep can be implemented rather rapidly, and may be applicable to other ruminants."

She will use other markers to get closer to the gene controlling heavy muscling via a process known as "chromosome walking."

Cockett's search for markers for Spider Lamb Syndrome (SLS) is taking longer. SLS is an inherited cartilage disorder of sheep associated with bowed legs and twisted spines. Afflicted lambs usually die within a year. Cockett has screened 28 of about 200 markers so far in an attempt to locate one associated with the ailment. The SLS marker could be the next candidate marker she screens—or the 200th.

As many as 70 percent of Suffolks were once suspected of being carriers of the recessive gene for SLS. Spider Lamb Syndrome has also surfaced in Hampshires, perhaps due to crossbreeding, says USU animal scientist and co-researcher Thomas Bunch. Currently, the only way to know if an animal is free of the recessive gene is to monitor offspring. Birth of even a single SLS lamb indicates that both parents are carriers of the SLS gene. Even then, a ram would have to sire 17 normal progeny to be nearly certain that it didn't carry the defective gene.

With an SLS marker, a simple blood test could identify carriers, letting producers eliminate this genetic deformity within a single generation.

In cattle, Cockett is studying the relationship between genes in the major histocompatibility complex (MHC) and economically important traits, such as disease and parasite resistance, and growth. In humans, this group of genes has been linked with resistance to several ailments, such as rheumatoid arthritis and insulin-dependent diabetes. In cattle, MHC has been linked to resistance to ailments such as mastitis and bovine leukemia.

Cockett has screened differences in the MHC genes using blood from cattle at a USDA research facility in Clay Center, Nebraska, Hereford lines from Montana State University, Lethbridge, Canada, and Colorado State University, and Holsteins from the University of Pennsylvania. To date, no trait has been convincingly associated with the MHC. The results have been variable—a gene associated with a trait in one group of cattle was





often not related to the trait in another group. It now appears that an MHC gene has less effect on growth traits than was once thought.

Cockett says gene sleuthing in livestock uses similar techniques as the multimillion dollar effort to map the human genome. DNA extracted from cells is cut into pieces with enzymes. Fragments of DNA containing a gene of interest form a pattern that indicates whether animals are genetically similar or different. Fragments of DNA associated with a trait help researchers hone in on a particular gene.

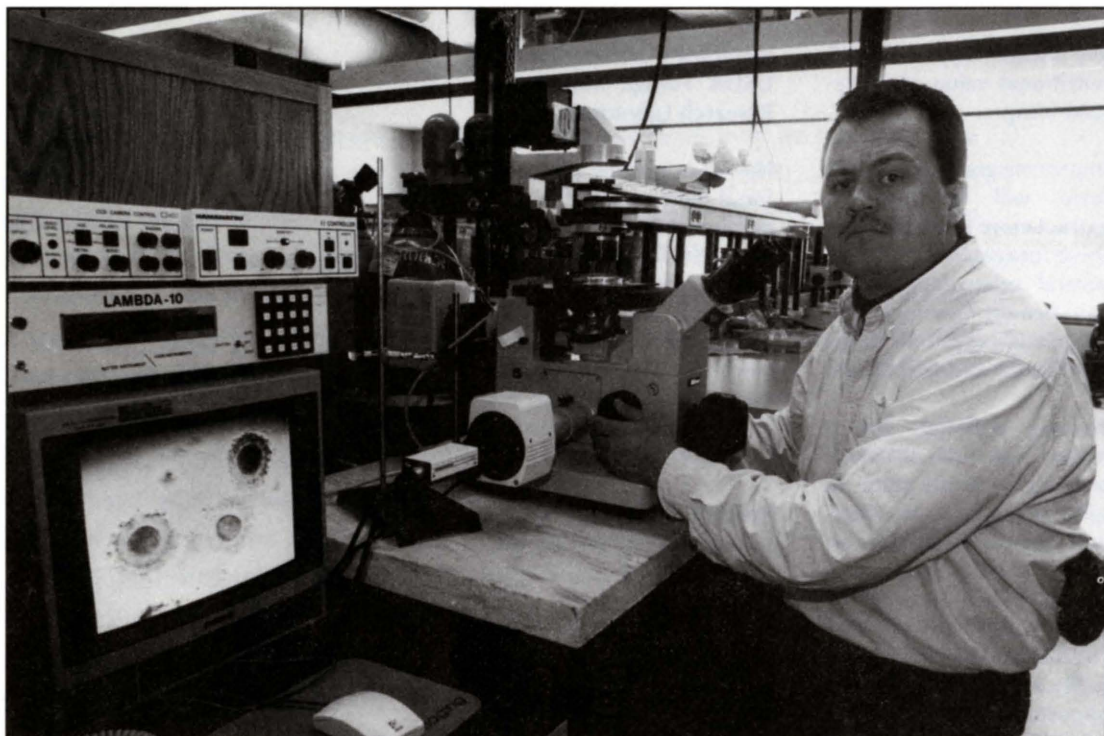
Because each cow has 100,000 or so genes, the outcome of even the most deliberate mating has always been in doubt. Muddled. Combining genes by mating is a lot like crowd control at a football game. Genes moved, but only *en masse*. Some less-desirable genes always tagged along with the good, just as hapless spectators can be swept along with a crowd.

No longer. Genetic tests for cattle are already available that can detect certain inherited diseases, the ability to produce certain forms of milk proteins, and an animal's parentage. Similar tests will soon be available for sheep, as will tests that determine the genetic potential of an embryo before it's implanted.

Gene by gene, researchers are creating a new era in livestock breeding and production.

KG

Tom Bunch 750-2148
Noelle Cockett 750-3903



Ken White

This Is No Bull: Sex Changes on Dairy Farms

The unvarnished truth is that dairy farmers—the good ones, anyway—spend a lot of time thinking about sex. That's o.k.—it's good for business.

Unless cows calve every year or so, milk production plummets and eventually ceases, which means that profits depend on earthy developments in the barnyard

IMPROVING THE BENEFITS OF GRAZING

We haven't tapped the full nutritional value of rangeland forages.

Improving grazing management will let livestock extract more nutrients from these forages, but there are several other tactics that can benefit livestock and rangelands, says USU range nutritionist Kenneth Olson.

Grazing definitely has a major role in livestock production in the state, in spite of pressure to eliminate livestock grazing on public lands. Olson says grazing probably won't be prohibited but is likely to be curtailed. "This is largely a political issue but there are opportunities to provide scientific information that shows the positive effects of grazing."

Olson is studying alternatives in the event that producers' access to public rangeland is restricted. One of the most promising alternatives is irrigated meadowlands, most of which are privately owned. "These areas have tremendous productive potential because of access to water," Olson says. Meadowlands are often used to produce hay, but they could be a grazing resource, particularly when planted to alternate forages such as the wheatgrass hybrids, wildryes and other

materials developed at the USDA Forage and Range Research Laboratory.

He is examining the seasonal dynamics of the production and quality of these alternate forages to maintain a high plane of nutrition, and also works with the Range Science Department to develop grazing methods that improve the quality of range vegetation on public rangelands.

Rangeland forages are a valuable resource. So, too, is grazing.

KG Kenneth Olson
750-37888

or, as is more often the case (because bulls are a rarity on dairy farms anymore), on the ability to manage reproduction.

Reproduction on dairy farms is a high-tech enterprise, and it's likely to become even more so. It's also a major chore, says Milan Shipka, manager of USU's 200-cow milking herd at the Caine Dairy Center, one that involves tasks such as heat detection, problem breeders, calving problems, conception rates and the number of services per conception, as well as sire selection.

A human fertility clinic is probably the only other business that lavishes so much science and technology on reproduction.

Dairy farmers' craving for technological innovations hasn't been satiated. For several decades they have used computerized records to chart a cow's productivity and reproductive cycles, balance rations and select sires. Artificial insemination is nearly customary, and transferring embryos from high-producing cows is becoming more common.

On tap are techniques that will modify genes to increase productivity and disease resistance, and to transfer genes so cows secrete pharmaceuticals and other high-value compounds in milk, transforming farming into "pharming."

And by the year 2000, current animal breeding methods may be replaced by a system in which eggs collected from outstanding cows are fertilized with sperm that have been selected to produce females. The resulting embryos will then be transferred to recipient females, says Ken White, USU embryologist. These techniques could markedly accelerate the rate of genetic progress, which is already high in the dairy industry, as indicated by increases in milk production despite fewer cows.

But there's a problem: Embryo survival rates in vitro are abysmally low, and, unless improved, could stymie these and other advances.

It's not that nature is stingy with either eggs or sperm: A cow produces thousands of eggs and a bull produces billions of sperm, which should theoretically assure an ample supply of embryos. In culture, however, few embryos survive to the stage where they are suitable for transfer.

Most cultured embryos fail to develop beyond the 8- or 16-cell stage of development, the point at which the dam relinquishes control of embryo development and the embryo takes charge of its own destiny.

"*In vivo*, embryos are exposed to a dynamic environment," White says, one which includes fluctuating levels of hormones and substances such as growth factors. White has added several of these growth factors, individually and in combination, to the culture medium to determine how they affect embryo development. These growth factors have included platelet-derived growth factor, leukemia inhibitory factor, stem cell factor, transforming growth factor β , and epidermal growth factor.

"Some growth factors show a remarkable ability to promote embryo growth past the 8-cell stage of growth," White says. For example, one growth factor allowed about 70 percent of the bovine and sheep embryos to survive to the blastocyst stage, far more than the 15 percent survival rate in conventional media.



White's is also studying nuclear transplantation, a technique in which a cell of an embryo, one at the 32-cell stage of development, is fused with an egg whose nucleus has been removed. The technique can be used to clone embryos, which could further accelerate genetic progress. However, about 95 percent of these embryos die during removal of the genetic material from the egg during enucleation, when the embryonic cells are fused with the egg, and when the single cell from the embryo must be "reprogrammed" to develop as if it were a single-cell. These aspects have been extensively studied. White is studying another aspect of mortality—the activation of the embryo, which occurs when the egg is fertilized.

In several species, activation is accompanied by calcium fluxes in intracellular fluids. Researchers have tried to duplicate activation by subjecting embryos to electrical pulses, which create small pores in the cell membranes, thus allowing an influx of calcium from the culture medium and activating the embryo. However, calcium levels are often so high that they kill the embryo.

About a year ago, White hypothesized that the compound inositol 1,4,5-triphosphate (IP3) might have an integral role in calcium release. It did. Including IP3 in the culture medium resulted in calcium pulses that mimicked those associated with activation, and even encouraged the development of unfertilized eggs. "These results suggest that we are approaching an environment that more closely duplicates the physiological state required for development," White says, thus bringing embryo culture and cloning a step closer to practicality.

As a result, cows' genetic ability is likely to improve as reproduction becomes more clinical. Kids won't learn the facts of life from this type of sex, but it will help farmers milk more profits from their cows.

KG

Ken White 750-2149

Genetic Engineering for Resistance Against Bovine Virus Diarrhea

A USU researcher is determining whether it's possible to genetically engineer cattle that are resistant to bovine virus diarrhea (BVD).

BVD virus, like other viruses, is believed to enter cells when its surface proteins interact with proteins on the receptors of cell membranes. USU virologist Keven Jackson hopes to engineer cells so they produce a protein that occupies these sites, thereby blocking occupation and cell entry by BVD virus.

In experiments involving transgenic mice, Jackson used a gene that governs expression of a glycopro-



Keven Jackson



tein similar to that on the surface of murine leukemia virus (MLV).

"Homozygous transgenic mice appeared to be completely resistant to MLV and heterozygous mice were partially resistant to MLV," Jackson says. Even though MLV and BVD viruses differ in several important respects, both use the same mechanism to enter cells. Both are encapsulated in lipid membranes that contain virus glycoproteins which facilitate entry into cells.

Jackson will clone the BVD virus gene that expresses virus glycoprotein, the counterpart to the MLV gene used in the experiments involving mice, and transfer it into bovine cells in tissue culture. If the gene is expressed and confers resistance to BVD in tissue culture, it will be tried in cattle.

BVD virus causes diarrhea in adult animals, and abortion, stillbirth and congenital defects in fetuses. Losses are difficult to estimate, but one study estimated that BVD-related losses were several thousand dollars annually in a single dairy herd.

If the gene does confer resistance, it would be possible to introduce it into the genome of cattle, who would then pass on resistance to their offspring.

Jackson says the major limitation to transgenic livestock is the high cost and low success rate of current methods. Public apprehension about transgenic livestock and regulations are also impediments, although the public may view disease-resistant transgenic cattle, most of which would otherwise probably be naturally infected with the virus, more favorably than, for example, the reception accorded the use of bovine somatotropin in dairy cattle.

KG

Keven Jackson 750-1887



Better Treatments for a “New” Disease

The protozoan parasite, *Cryptosporidium parvum*, has probably been lurking around forever, but has

acquired notoriety in recent years due to our misfortunes.

It cause a cholera-like diarrhea in livestock and humans. Until recently, however, this parasite of the intestinal tract went largely unnoticed—the disease it causes, cryptosporidiosis, wasn’t described in livestock until 1971, and the first human case wasn’t reported until 1976. Since then, however, *C. parvum* has become a major threat to AIDS patients, whose compromised immune systems are unable to counter the parasite.

The parasite is also far more prevalent and causes much higher losses in livestock than was once recognized. The estimated livestock losses in the U.S. due to cryptosporidiosis exceed \$6.2 million annually.

USU veterinary scientist Mark C. Healey, who is studying the parasite's immunobiology and is identifying drugs to treat the disease in animals and humans, says cryptosporidiosis occurs worldwide. Young children and animals are especially vulnerable.

Cryptosporidial infections have increased markedly since 1982, largely due to the increase in the number of AIDS patients. These infections could markedly increase mortality due to AIDS. Medical costs associated with AIDS treatment, are expected to reach \$15.2 billion in 1995 from \$10.3 billion in 1992.

Livestock losses are difficult to assess, but a survey of 13 dairy herds in Cache Valley by USU's Animal Disease Diagnostic Laboratory several years ago indicated approximately half the calves less than 4 weeks of age were infected with *C. parvum*. Diarrhea is the largest single cause of death among young calves, and cryptosporidiosis may be a major cause.

According to a recent survey by the USDA's Animal and Plant Health Inspection Service, the parasite is present on more than 90 percent of dairy farms, and is found in virtually all large and medium-sized herds. The organism is difficult to eliminate and the lack of a specific anti-cryptosporidiosis treatment means only the symptoms can be treated to relieve diarrhea and dehydration.

It is difficult to eliminate the parasite, although good hygienic methods will reduce the load of this and other parasites in the environment.



Please turn to page 23

Study Examines Role of Nitrate in Forest Soils

Because most forest soils contain only small amounts of nitrate, nitrate is thought to be relatively unimportant in the nutrient cycle of forests.

The presence of small amounts may mask the nutrient's larger role in maintaining the productivity of forests, says USU soil microbiologist John Stark. For example, even though there's very little nitrate in undisturbed forest systems, nitrate hemorrhages from logged sites, a phenomenon which may be due to a decrease in utilization rather than a change in the rate of production.

Stark says the loss of nitrogen has several detrimental effects—a marked reduction in the productivity of forests, increased levels of nitrogen trace gases that degrade ozone, thereby contributing to global warming, and water pollution.

To determine the production and consumption of nitrate, Stark and a colleague at Northern Arizona University will study soil on 10 sites, 5 in New Mexico and 5 in Oregon. The sites are located on the coast and at various elevations on inland sites.

Nitrate is produced and consumed simultaneously, so monitoring the production and consumption of nitrate is somewhat like determining how much water there is in a leaky cup that lets water flows out as soon as it enters. Injecting soil with a solution containing a stable isotope of nitrogen will let Stark determine how quickly the isotope disappears through consumption and how quickly it is diluted by natural isotopes.

The researchers will also determine how carbon and ammonium affect the manufacture and consumption of nitrate and the role of microbes in the nitrate cycle. The conventional view is that soil microorganisms don't absorb nitrate, but Stark says that doesn't appear to be true of microbes in forest ecosystems.

Determining the fate of nitrates in forest ecosystems may lead to new ways to mediate disturbed forests, thereby keeping nitrates within forests and preventing them from polluting air and water.

Stark's research is funded by the Utah Agricultural Experiment Station, the National Science Foundation and the United States Department of Agriculture.

LH

John Stark 750-3518

Soil Climate Study Nearly Complete

The Utah landscape is certainly diverse, and that includes its soil climate.

Soil climate?

Yes, soils have climates—aridic, thermic, xeric and frigid—which are important factors in determining land use.

USU soil scientist Janis Boettinger is completing a study of Utah's soil climates that USU soil scientist Al Southard, in cooperation with the Utah Climate Center, Bureau of Land Management and the Soil Conservation Service, started in 1983.

Southard placed data pods throughout the state to measure and record soil temperatures and soil moisture levels. Computers at 26 sites record the high and low temperatures for each 24-hour period at depths of 10 and 50 centimeters. Soil moisture is also measured daily 18 and 46 centimeters below the soil surface.

The sites are located throughout the state at a wide variety of elevations, in various climate zones and in many types of soil.

Soil climate encompasses soil moisture and temperature. Soil climate is affected by the atmospheric

climate, as well as by slope, aspect, infiltration rate, soil water-holding capacity and other soil properties.

Data gathered over the past 10 years are already guiding land use decisions, such as determining suitability for grazing, irrigation scheduling, the feasibility of raising agronomic crops, and to answer other questions about forest and range management. Information about soil moisture information has also been extremely useful during the drought.

USU soil scientist Philip Rasmussen combines the data with infrared remote sensing system to chart and quantify rangeland and dryland plant productivity; the results will be used by state and federal agencies to make land-use decisions.

LH

Janis Boettinger 750-4026
Philip Rasmussen 750-2230

"Ecoscapes" for the Arid West

Ecoscaping. Ecological auto pilot.

Those are some of the terms that Roger Kjelgren, USU horticulturist, uses to describe landscapes that require minimal maintenance and water.

Kjelgren studies how woody plants fare in landscapes in the arid west. He hopes to change conventional

landscaping, which now often consists of a solitary shade tree surrounded by expanses of irrigated turf.

"We need more information on water use so people can create the environment they want without overusing resources," Kjelgren says.

Kjelgren measures evapotranspiration rates and monitors the condition of several green ash and Norway maple trees grown under different irrigation regimes. These trees are commonly grown in Utah, but Kjelgren is also developing mathematical models of water use for other species. The model will help homeowners select trees that fit their landscape and water availability, as will his research concerning the compatibility of trees with turf and with woody plants.

At the Experiment Station's Greenville Farm in North Logan, trees are planted in pink plastic tubes that were designed to prevent animal damage. The tubes also act as miniature greenhouses and accelerate growth.

Trees grown in the tubes use substantially less water than their unprotected counterparts—water use is just 10 percent of the potential evaporation rate, Kjelgren says. Temperatures inside the tubes are 8 to 10 degrees warmer than outside temperatures.

During the summer, relative humidity inside the tubes increases to 60-80 percent, much higher than the 10-15 percent of surrounding air. Another advantage—moisture condenses on the tubes as evening temperatures drop, Kjelgren says. The tubes also reduce the amount of sunlight reaching the trees by about 30 percent.

The tubes disintegrate after five to six years of exposure to sunlight, when trees are well established.

LH

Roger Kjelgren 750-2972

Garland Winter Wheat

Released by
Utah Agricultural
Experiment Station

The Utah Agricultural Experiment Station has released Garland, a new variety of hard red winter semi-dwarf adapted to irrigated conditions.

Garland is a replacement for Ute, a popular semidwarf variety, says David Hole, USU small grain breeder. Garland is resistant to mildew (Ute is susceptible) and is more resistant to dwarf smut than is Ute.

Compared to Ute, Garland produces higher yields (the 4-year average yield at Logan is about 150 bushels per acre), has a heavier test weight (by about 3 pounds per bushel), and is shorter (by about 2 to 3 inches). They also differ in chaff color—white in Garland and bronze in Ute.

Hole says some registered and certified seed of the new variety will be available for planting during the fall of 1993. Plant variety protection is being sought for Garland, which means it may be sold only as a class of certified seed.

Good nitrogen management is necessary for high yields of high-quality grain. Late applications of nitrogen have increased grain protein. Milling quality and protein levels are similar to Ute. Garland's kernel type is typical of winter wheat and should avoid the grading problems associated with Ute.

Garland was designated as UT1706-1 during testing and was briefly referred to as 'Sundance.'

David Hole 750-2235

Designing Safer Deer Crossings

Why do deer cross the highway?

To get to the other side of course, preferably without stepping in front of a car.

There may be ways to help big game and cars coexist better on highways, thanks to research by several government agencies and the Utah Cooperative Fish and Wildlife Research Unit at USU.

It's a big problem. There were more than 3,000 deer-vehicle collisions annually in Utah between 1981 and 1990, according to the Utah Division of Wildlife Resources (UDWR). Each resulted in an average of \$1,200 in vehicle damage, according to Farmer's Insurance Bureau records. In Utah, three people were killed following deer-vehicle collisions during 1991-92.

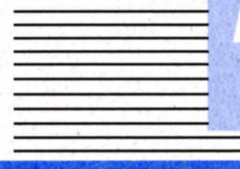
Wildlife officers estimate car-deer encounters by counting animal carcasses, but many fatally injured animals wander off, explains USU professor and research unit leader John Bissonette. Studies in Colorado indicate that only half of all deer mortality is documented.

Bissonette and graduate student Laura A. Romin are cooperating with the Bureau of Reclamation, the Utah Department of Transportation, the U.S. Fish and Wildlife Service and the UDWR to develop better big-game crossings around the newly-constructed Jordenelle Reservoir in northeastern Utah.

Before the reservoir was built, two roads bisected the valley floor, which serves as winter range for deer in the area, and UDWR officials estimated that 12 deer in the area were killed annually due to vehicle collisions. Officials thought that twice as many deer might be killed during dam construction when three roads served the area.

In fact, 173 deer were killed in collisions the year after the new roads were in operation. Because the animals' habitat was drastically disturbed, federal regulations required that safer crossings must be provided.

Overpasses or deer tunnels are usually provided for deer, but Larry Dalton, coordinator of the Central Utah Project for the UDWR designed simpler, less expensive structures.



More than 30 miles of big game-proof fencing will be constructed along the three roads, interspersed with crossings, where cattle guard stripes on the road and large cobbles on the shoulders and in the median will discourage deer from veering off the 5-foot-wide path.

Romin and Bissonette are determining where crossings should be located. Romin documents deer mortality along the roads and conducts spotlight searches for animals in areas surrounding the dam site. She also determines how habitat and terrain influence where big game cross.

LH

John Bissonette 750-2509

Weevil Control of Canada Thistle Appears Promising but Slow

Thistle weevils haven't yet eliminated Canada thistle from experimental plots, but that doesn't mean the biocontrol (biological control) method won't eventually work.

"We need time to establish high-density populations of stem mining weevils," says USU entomologist Ted Evans, who is studying the effectiveness of musk

thistle weevils and stem mining weevils in the control of Canada thistle on a site east of Randolph in Rich County. The Bureau of Land Management fenced off the area 20 years ago to allow the heavily grazed streambank to recover, a move which facilitated the spread of Canada thistle.

Two years ago, Evans and Nadeer Youssef, a graduate student, introduced large numbers of the stem mining thistle weevils on plots in the thistle-dominated area. (Musk thistle weevils were already present at the site.)

Weevils seemed an attractive alternative because herbicide control was ineffective. There was also the need to limit herbicide use in environmentally sensitive areas such as streambanks.

Half the plots were experimentally infested with stem mining weevils. As expected, infestation rates dropped slightly as stem mining weevils moved into adjacent areas. Last year, infestation rates on stems on previously uninfested control plots increased to 15 percent.

So far, the stem mining weevils have not significantly reduced the density of Canada thistle, which is not surprising since this type of control usually takes a long time, Evans says.

Stem mining weevils were introduced from Europe and have become common in North America but are not well established in Utah. As their name implies, the stem mining weevils bore through plant stems, weakening plants so they die during the winter. Research in Montana indicated that high infestations are required to appreciably damage the thistle, but much needs to be learned about the rate at which weevils increase and how quickly weed populations decline.

The musk thistle weevil feeds on the seed heads of weeds and inhibits their reproduction, and has curbed the spread of the musk thistle. However, Youssef found that it does not appear to be a good candidate for controlling Canada thistle because the thistle matures too late in the summer to be subject to attack by large numbers of the weevil. Evans says the seasonal timing between plant and insects is a common problem in biocontrol.

The researchers are also studying other insects that may keep the thistles in check.

LH

Ted Evans

Breeding Cattle That Thrive on Poor-Quality Forage

Do cattle inherit their ability to utilize poor-quality forages?

USU animal scientist Randy Wiedmeier is trying to find out. His interest in the topic was prompted by dramatic differences in how cows fared on low-quality forages. Some thrived on straw-based rations and maintained their weight, even after calving. Other

cows on the same nutritional regime fared poorly, and lost several hundred pounds during the winter, despite no apparent differences in breed or other factors.

To delve into these differences, Wiedmeier is studying 60 Herefords that have been divided into three groups. Cows in each group were bred to genetically diverse Hereford bulls, each known for different traits.

The cows were managed the same during the winter. Wiedmeier will determine whether their calves differ in their digestible dry matter intake after weaning and as yearlings.

"If there are large differences between the groups of calves sired by different bulls, we can then calculate the heritability of the trait, and select cows and bulls to amplify the genes," Wiedmeier says. This would make it possible to determine the physiological or anatomical characteristics that allow cattle to utilize nutrients more efficiently, and to search for genetic markers associated with the trait.

Wiedmeier says other studies show that forage utilization is a heritable trait, but he has not found any studies that have determined whether the ability to utilize low-quality forages is inherited.

These differences don't surface until cows experience nutritional stress, Wiedmeier says.

If the differences are genetically determined, a simple blood test could be used to select cattle that can better utilize the nutrients in poor-quality forages.

KG

Randall Wiedmeier 750-2151

Field Days and Other Events

Dryland Crops Field Day

Nephi Dryland Field Station, Levan Ridge
Tentative date: July 14
(actual date will depend on weather conditions and crop maturity)

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Irrigated Crops Field Day

Greenville Farm, North Logan
Tentative date: July 21

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(801) 752-6263

Utah Botanical Garden

May 18, 5 p.m. Starting a compost heap
May 27, 5 p.m. Growing bearded iris
September 4 Open House

Contact:

William Varga
Director, Utah Botanical Garden
Plants, Soils & Biometeorology Department
Utah State University
Logan, UT 84322-4820
(801) 750-2252

or (801) 451-3204

Land Grant Days

Policies for Public Lands
USU Campus
September 27

Contact:

Utah Agricultural Experiment Station
Utah State University
Logan, UT 84322-4810
(801) 750-2206

Dairy Field Day

Caine Dairy Teaching and Research Center
Wellsville
October (date to be announced)

Contact:

Wallace Taylor
Extension Dairy Specialist
Animal, Dairy & Veterinary Sciences
Department
Utah State University
Logan, UT 84322-4815
(801) 750-2164

Recent Grants & Contracts

Bruce Bugbee, Plants, Soils & Biometeorology Department, is studying the phytotoxic effects of pesticides with support from Environmental Technology Associates.

Edward Evans, Biology Department, studies the biological control of noxious weeds with support from the Utah Department of Agriculture.

Jeffrey Broadbent, Nutrition & Food Sciences Department, is characterizing the stress proteins in dairy Lactobacilli to improve the ripening of low-fat cheese. His research is supported by the National Dairy Promotion and Research Board.

Jay Andersen, Economics Department, is studying the impact of wilderness designation on grazing rights and Federal water rights. His research is funded by the Utah Department of Community and Economic Development.

Donald Smee, Animal, Dairy & Veterinary Sciences Department, is studying plant-derived immunomodulators (Anver/Bioscience) and new agents against murine cytomegalovirus (SRI International).

The Animal and Plant Health Inspection Service (USDA) funds research to determine the distribution and elimination of goatsrue by **John Evans**, Plants, Soils & Biometeorology Department.

Robert Hill, Biological & Irrigation Engineering Department, conducts energy and irrigation audits with funding from the Utah Department of Agriculture.

Brien Norton, Range Science Department, is examining the role of small ruminants in sustaining agropastoral systems in drought-prone environments with support from the University of California-Davis.

Mary Barkworth, Biology Department, has received funding from the Agricultural Research Service (USDA) to complete *The Manual of North American Grasses*.

Bruce Miller, Agricultural Systems Technology & Education Department, is studying hay-handling systems with funding from the Utah Department of Agriculture.

Donald Jensen, Utah Climate Center, is evaluating the frequency of precipitation and its possible implications on dam safety, the effects of climate change in Utah, and methods to improve the satellite collection of weather and river data. The studies are supported by the Bureau of Reclamation (US Department of the Interior).

Gary Belovsky, Fisheries & Wildlife Department, is studying the roles of food abundance, competition and predation in limiting grasshopper populations. His research is funded by the Animal and Plant Health Inspection Service (USDA).

John Huffman, Animal, Dairy & Veterinary Sciences Department, is studying antiviral agents against cytomegalovirus with support from SRI International.

The National Institutes of Health supports model development and evaluation of therapies for *Cryptosporidium parvum* infection by **Mark Healey**, Animal, Dairy & Veterinary Sciences Department.

Continued from page 14

Cryptosporidiosis can be transmitted from animals to humans. The organism contaminated the water supply of Milwaukee, Wisconsin, this spring. Cases of cryptosporidiosis have occurred in residents of day care centers, travelers, animal handlers and veterinary students, including an outbreak in 10 veterinary students who had worked with young calves.

Infection is particularly dangerous because there's not a single chemotherapeutic agent that is consistently effective against *C. parvum*, even though more than 100 drugs have been tested, Healey says.

USU researchers have developed a mouse model for cryptosporidiosis and are also developing methods to grow the protozoan in cell culture in order to quickly screen drugs.

Healey's research is funded by the National Institutes of Health.



KG

Mark C. Healey 750-1901

The Caine Dairy Center

If you were designing the best possible dairy cattle research and teaching facility, you would be hard-pressed to improve on what's available at USU's Caine Dairy Teaching and Research Center.

Cows thrive here, and—as its name indicates—so do teaching and research.

Cattle were moved onto the farm in February 1986, but the facility still isn't fully completed, says Milan Shipka, who has managed the farm since January 1991. There have been several changes at the center since his arrival.

One was the replacement of the original double-four, side-opening milking parlor with a double eight, rapid exit herringbone parlor, a change that markedly improved the efficiency of milking.

"It previously took two students more than six hours, twice a day, to milk the herd. With the new parlor, the herd can be milked in about three hours. One person could handle the milking, although we use two students because most haven't had any previous experience in a dairy herd," Shipka says.





Because alternative milking facilities weren't available during construction, cows were milked in the parlor during the transition, which isn't something that Shipka recommends. "It's difficult to milk when jackhammers are running," Shipka says. The construction-related stress caused average milk production to decrease to 48 pounds from 68 pounds. "A producer who is considering such a change should also consider the cost of lost milk production that might be involved," Shipka says. Some cows

were affected throughout their entire lactations.

Also installed was an automatic system that records the identity and milk weight of each cow. Other visible changes include the construction of two more loose housing barns, one for dry cows and one for heifers, which reduces the number of times cattle must be moved. Previously, the lack of space meant that dry cows and 6-month-old heifers were transported to another farm until they were ready to calve.

Space is still at a premium, however, and heifers must still be moved when they reach 13 months of age. Shipka hopes that two more loose housing barns can be built to accommodate the entire herd.

"When it concerns dairy facilities, no university has a farm of this caliber, although some are constructing facilities that may match those at the Caine Center," Shipka says.

Shipka also praises the genetic ability of the herd, which ranks in the top tier of university herds. The herd's rolling herd average of 21,000 pounds of milk also places it among the top producing herds in the state.

The 200-cow milking herd is used in a variety of research projects (see the related articles in this issue) and by students enrolled in the vocational and four-year programs. The facility lets students gain hands-on experience in all aspects of dairying.

But Shipka does have one minor concern. Some people feel that they might not be welcome at the facility and are hesitant to visit, perhaps because they fear they might interfere with research or day-to-day business.

"This is a public facility and visitors are always welcome to stop by and visit," Shipka says.



Ewes Don't Transmit Scrapie to Unborn Lambs

No one knows how scrapie is transmitted, but a ewe apparently doesn't transmit the disease to a lamb before it enters the birth canal.

That's according to a recent USU study involving 198 embryo transfers. When embryos from infected sheep were transferred to uninfected ewes, none of the recipient ewes developed scrapie. Neither did embryos from uninfected ewes that were transferred to scrapie-inoculated sheep.



Lambs were removed via Cesarean section and reared in a scrapie-free environment so they weren't exposed to the disease outside the uterus.

Most of the animals were observed for 5 years, which should have been long enough for any infected animal to show signs of the disease, says USU veterinary scientist Reed Holyoak.

Ewes were inoculated with the scrapie agent, which may differ from

the manner in which sheep naturally contract the disease. Researchers are now transferring embryos from naturally infected ewes to scrapie-free recipients. If the lambs are scrapie-free, embryo transfer could be a way to salvage offspring from infected flocks.

The study was funded by the Animal and Plant Health Inspection Service of the USDA, part of an effort to control and eradicate scrapie, a neurodegenerative disease that primarily affects sheep. The study also involved USU animal scientist Warren Foote, USU veterinarian Jay Call, and researchers with the USDA and Utah Department of Agriculture.

Scrapie is similar to several other baffling diseases, such as kuru and Creutzfeldt-Jakob disease in humans and bovine spongiform encephalopathy (BSE), which cattle in Great Britain apparently contracted by consuming feed supplements made from improperly rendered sheep offal.

"The brains of scrapie-infected sheep have a moth-eaten appearance and large vacuoles in the neurons are filled with amyloid plaques, which also characterizes similar diseases in other species, and Alzheimer's disease in humans," Holyoak says, although as far as is known, the two ailments are not otherwise related.

Scientists have experimentally transferred some of these diseases between species, but natural spread of scrapie has occurred only between sheep and goats.

"The brains of young calves inoculated with scrapie-infected sheep brain came down with a form of BSE, but the brain lesions differed from those found in infected cattle in Great Britain, which means that BSE is caused by a different type of scrapie, or is an entirely different disease than scrapie," Holyoak says.

The scrapie agent, which differs from other pathogens such as fungi, bacteria, and viruses, has never been isolated and identified. Scrapie's long incubation period also hampers research and eradication.

BIOTECH COULD BENEFIT BIGHORNS

Wildlife can also benefit from the same type of research that's identifying genes to improve livestock production.

One potential beneficiary is the Desert bighorn sheep, whose ranks in Utah have been thinned by *Pasturella* pneumonia in recent years.

"*Pasturella* pneumonia probably kills more bighorn sheep than all other diseases combined," says USU animal scientist Tom Bunch, who has studied bighorn sheep since 1971. Bunch and molecular geneticist Noelle Cockett are now determining whether resistance to this type of pneumonia is linked to certain genes. Similar types of resistance have been identified in domestic livestock.

Desert bighorns have been particularly hard hit; about 500 have died in recent years, many in the area south of Canyonlands National Park. The state's population of Desert bighorns is estimated at 1,300-1,600.

Domestic sheep have evolved defenses against *Pasturella* organisms but bighorns have not and can contract the disease from domestic sheep. This has increased pressure to restrict grazing in some areas.

The range of bighorns also exacerbates spread of the disease. For example, a ram in Arizona outfitted with a transmitter traveled more than 130 airline miles before returning to home base.

"It's just a matter of time before genetic engineering can be applied to save wildlife," Bunch says. In this case, curbing a disease in wildlife would also minimize conflicts between wildlife managers and livestock producers.

KG

Tom Bunch
750-2148

gene. "The test that we have developed for Cheviots appears to be 99.5 percent accurate in determining whether an animal is susceptible to a specific strain of scrapie," Maciulis says.

Suffolk and Rambouillets have different forms (polymorphisms) of the gene than do Cheviots. White-faced sheep such as Rambouillets are supposedly the least susceptible to scrapie. After sequencing the PrP gene in these breeds, she will determine what polymorphisms exist and whether they are linked to the length of the incubation period.

However, scientists have identified both a protein that appears to be closely associated with scrapie infectivity and the gene that controls synthesis of the protein. The protein, protease-resistant protein (PrP), also appears to be linked with or may be the same as a gene that controls length of the incubation period. The gene for length of the incubation period (the Sip gene) has been studied in mice, goats and sheep. Sheep with the long incubation die of other causes before they are affected by scrapie, although it's not known if they disseminate the disease agent during this time.

USU research associate Alma Maciulis is sequencing the DNA extracts from three breeds of sheep (Cheviots, Rambouillets, and Suffolks) to develop a test for the Sip

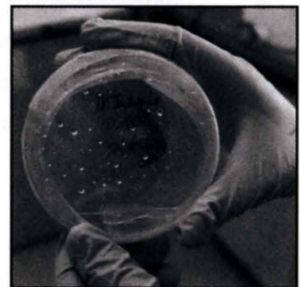
Holyoak says the disease organism causing scrapie—whatever it is (some researchers call it a prion)—is remarkably resilient and survives normal sterilization techniques. For example, it has survived storage for seven years in formaldehyde. It's not completely invulnerable however: Incineration, autoclaving at high temperatures and pressure, and sodium hydroxide will kill it.

Nonetheless, Holyoak says more must be learned about the survival of the scrapie agent to determine how long facilities must be free of sheep to avoid any risk of infection by contaminated premises.

Learning that lambs in utero aren't infected is good news, but there's plenty more to learn about the disease.

KG

Reed Holyoak 750-1881
Alma Maciulis 750-3220



New Techniques Mean More Calves

Good calves come from good cows. And while embryo transfer can result in more calves, too many top cows either stop responding to superovulation techniques or become infertile.

USU researchers can now bypass these problems by harvesting the ova (eggs) directly from follicles in the ovaries. They use ultrasonic images to locate the follicles that contain eggs, and to carefully guide an elongated needle through the wall of the vagina to puncture the follicles. The immature ova are then removed with gentle suction and aspiration.

Depending on the cow and the frequency of collection, about 2 to 10 immature ova can be collected every month. Some of the ova are used to develop *in vitro* culture techniques. (See related story this issue.) Genmark, Inc., a Salt Lake City biotechnology firm, also fertilizes some eggs and clones the resulting embryos for transfer.

The technique, which is known as ultrasonographic-guided ovum pickup, was originally developed to circumvent human infertility. It now promises to markedly accelerate the pace of genetic improvement in the dairy industry, says USU veterinary scientist Reed Holyoak.

Ultrasonic images can also be used to diagnose pregnancies 22-26 days after conception in cattle, and even sooner in mares.

Due to the stress of milk production and other reasons, infertility tends to be more common among top-producing cows. In only about 10 percent of the cases can the

FOILING A PARASITE OF POULTRY

causes of infertility be determined. Most do not appear to be due to inherited traits.

Until now, infertility would have deprived producers of valuable genetic material from these cows. Eggs for *in vitro* fertilization can be harvested from slaughterhouses, but they are from cows of uncertain genetic ability. Superovulation is usually more successful with heifers. However, heifers have not proved their genetic ability and the resulting calves could represent a step backward in genetic progress.

The follicular fluid appears as a dark spot on the ultrasonographic image. The diameter of aspirated follicles ranges from about 1/8 inch to 3/8 inch. Follicles can be aspirated from the ovaries every week if needed, but are usually collected biweekly or monthly. Ova are matured in special media and incubated until they are ready to be fertilized.

Cattle usually have several immature follicles, of which one becomes dominant and ovulates every 21-22 days. However, all follicles contain ova that can be harvested any time during the estrous cycle before the follicles regress.

KG

Many parasite's have complicated life cycles, but few can match that of *Eimeria tenella*, the protozoan that causes highly contagious cecal coccidiosis in chickens, which saddles poultry producers with losses totaling millions of dollars annually. The life cycle of *E. tenella* involves several asexual and sexual forms of reproduction.

Suffice to say that such a life cycle aids the parasite's survival. Interrupting this life cycle could also be fatal to the parasite, which is the tack that USU veterinary scientist Mark C. Healey is using in his efforts to protect chickens from the disease.

Healey is trying to block fertilization at a particular stage during the protozoa's life cycle. First, however, his research team developed a system to produce *E. tenella* oocysts, the infective stage of the parasite, *in vitro* in order to study the parasite. They also developed a strain of *E. tenella* that consistently produces more than twice as many oocysts as the original strain.



Healey has produced several monoclonal antibodies and will test them to determine if any block fertilization in gamonts, the sexual stage of the parasite's life cycle. The monoclonal antibodies probably derive their effectiveness by blocking gamont receptor sites required for fertilization.

If some monoclonal antibodies do block fertilization, Healey will identify the target antigen recognized by these monoclonal antibodies. The antigen can then be produced and used as a subunit vaccine, thereby causing chickens to produce their own polyclonal antibodies to block *E. tenella* fertilization.

KG Mark C. Healey
750-1901

Reed Holyoak 750-1881

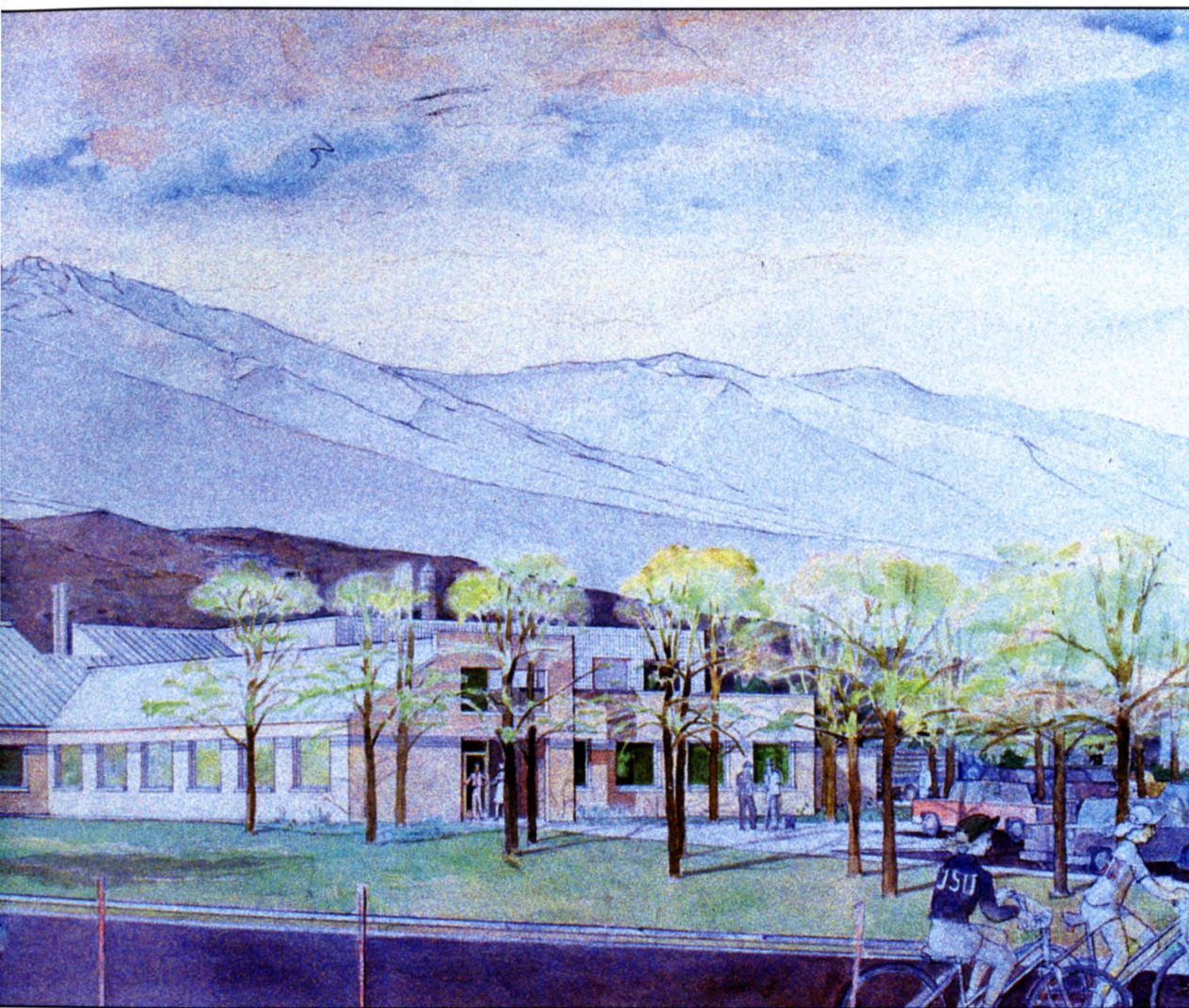
Construction Slated for New Animal Disease Diagnostic Laboratory

After years of planning, construction of the new \$4.5 million Animal Disease Diagnostic Laboratory is slated to begin this spring at a site east of the university Motor Pool on 1400 North in Logan.

The new facility will replace the cramped and outdated facility on the USU campus. "The facilities at the new diagnostic laboratory will be ideal," says veterinary pathologist Ross Smart, director of the laboratory. "The division into three units—necropsy, administrative and laboratory suites—will be an extremely efficient arrangement."

The new facility will contain more than 20,000 square feet. Construction will probably take at least a year. In addition to upgrading diagnostic capabilities, the new location means that it will no longer be necessary to transport animal carcasses through campus.





The Animal Disease Diagnostic Laboratory is an essential component of a system that protects the state's \$600-million livestock industry. The facility is widely used by veterinarians, state and federal officials, and animal owners.

The laboratory and a branch laboratory at Provo are supervised by the Utah Department of Agriculture and are staffed by USU.

KG

Ross Smart 750-1883